DECLARATION

I, Mari Kawanishi, a staff member of TAIYO, NAKAJIMA & KATO, Seventh Floor, HK-Shinjuku Bldg., 3-17, Shinjuku 4- chome, Shinjuku-ku, Tokyo 160-0022, Japan, do hereby declare that I am well acquainted with the English and Japanese languages and I hereby certify that, to the best of my knowledge and belief, the following is a true and correct translation made by me into the English language of the accompanying copies of the documents in respect of Japanese Patent Application No.2000-29656 filed on 7th February 2000 in the name BRIDGESTONE CORPORATION.

Dated this 21st day of January, 2003

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[DOCUMENT NAME]	Application for Patent
[REFERENCE NUMBER]	BRP-00003
[FILING DATE]	7th February 2000
[CONSIGNEE]	The Director General of the Patent Office
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[INDICATION OF FEE]		
[I. D. NUMBER IN ADVANCE PAYMENT REGISTER]		006839
[AMOUNT OF FEE]	21000	
[LIST OF FILED DOCUMENT]		
[DOCUMENT]	Specification	1
[DOCUMENT]	Drawings	1
[DOCUMENT]	Abstract of the Disclosure	1
[GENERAL POWER OF ATTORNEY NUMBER]		9705796

[DOCUMENT NAME] SPECIFICATION

[TITLE OF THE INVENTION]

TIRE

[WHAT IS CLAIMED IS]

[Claim 1] A tire comprising:

a tread;

at least one groove formed in said tread; and

a plurality of smaller grooves formed in the walls of said groove so as to extend in the longitudinal directions of said groove,

wherein said smaller grooves have a depth set within a range of 0.01 to 0.3 mm and a pitch set within a range of 0.01 to 0.3 mm.

[Claim 2] A tire comprising:

a tread;

a plurality of grooves mutually intersecting and being provided in said tread; and

a plurality of smaller grooves formed in the walls of said grooves so as to extend in the longitudinal directions of said grooves, wherein:

said smaller grooves have a depth set within a range of 0.01 to 0.3 mm and a pitch set within a range of 0.01 to

0.3 mm; and

the walls in the vicinity of the confluence of said grooves are provided with turbulence generating zones for generating minute turbulences in a fluid flowing in the vicinity of the groove walls to thereby suppress separation of the fluid flowing in said grooves.

[Claim 3] A tire according to Claim 1 or 2, wherein the walls in the vicinity of the opening of said groove on the tread surface side are provided with turbulence generating zones for generating minute turbulences in a fluid flowing in the vicinity of the groove walls to thereby suppress separation of the fluid flowing in said groove.

[Claim 4] A tire according to Claim 2 or 3, wherein said turbulence generating zones have a multiplicity of pointed projections having a diameter within a range of 0.01 to 0.3 mm and a height within a range of 0.01 to 0.3 mm.

[Claim 5] A tire according to Claim 2 or 3, wherein said turbulence generating zones have a multiplicity of recesses having a diameter within a range of 0.01 to 0.3 mm and a depth within a range of 0.01 to 0.3 mm.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to a tire and, more particularly, to a tire improved in the wet performances.

[0002]

[Prior Art]

The tire is provided in its tread with a plurality of grooves for achieving the wet performances.

[0003]

In order to improve the tire performances on a wet road surface, such as the anti-hydroplaning performances or the wet braking performances, it is necessary to improve the drainage of the grooves.

[0004]

For improving the drainage, it is necessary to reduce the resistance between the fluid flowing in the grooves and the groove wall faces.

[0005]

Merely by roughing the groove wall faces, the surface area of the groove walls is increased to raise the resistance.

[0006]

As the tires having the rough groove wall faces, there have been proposed: (a) Japanese Utility Model Laid-Open No. 037708/1995; (b) Japanese Patent Laid-Open No. 201606/1992; (c) Japanese Patent Laid-Open No. 57704/1991; (d) Japanese Patent Laid-Open No. 009009/1989; (e) Japanese Patent Laid-Open No. 56205/1989; (f) Japanese Patent Laid-Open No. 16617/1993; and (g) Japanese Patent Laid-Open No. 151912/1999, for example.

[0007]

[Problems to be Solved by the Invention]

However, the various experiments and investigations of the above-specified proposals have revealed: that the proposals (a), (b), (c) and (g) were encountered by the problem of a raised resistance, that the proposals (d) and (e) were adversely affected by the turbulences in the flow by the sipes in the grooves thereby to increase the resistance, and that the proposal (f) had too large projections to control the flow and increased the groove surface areas to raise the resistance.

[0008]

Considering the facts thus far described, the invention has an object to provide a tire which can reliably reduce the resistance to a flow in grooves to thereby improve the wet

performances.

[0009]

[Means for Solving the Problems]

After the various experiments and investigations, the inventor of the present invention has found out that if a tread is provided in its groove wall with a group of minute grooves, that is, the so-called "riblets", extending along the flow and arranged transversely at an equal spacing and if the minute grooves have their spacing and depth set individually within a range of 0.01 to 0.3 mm, the frictional resistance between the water and the groove walls can be reduced, thereby improving the wet performances at an actual running time.

[0010]

It has also been found out that when the water in the grooves is separated from the groove walls, the resistance rises to lower the wet performances. Therefore, after the additional experiments and investigations, it has been found out that the separation can be suppressed by providing turbulence generating means for generating turbulent flows upstream of the separation point to impart the energy to the turbulent flow. It has also been found out that a number of minute recesses or projections in the vicinity of the corners of blocks are effective especially for the case of the block

pattern.

[0011]

In order to improve the anti-hydroplaning performances for a new tire, on the other hand, it has been found effective to suppress the separation, as might otherwise be caused at the walls of the grooves in the vicinity of the tread surface to provide a number of minute recesses or projections at the groove walls in the vicinity of the tread surface, i.e., at the groove walls in the vicinity of the tire surface in both the straight and block patterns.

[0012]

The present invention according to claim 1 is a tire comprising: a tread; at least one groove formed in the tread; and a plurality of smaller grooves formed in the walls of the groove so as to extend in the longitudinal directions of the groove, wherein the smaller grooves have a depth set within a range of 0.01 to 0.3 mm and a pitch set within a range of 0.01 to 0.3 mm.

[0013]

Next, operation of the tire according to claim 1 will be described.

[0014]

In the tire according to claim 1, the smaller grooves having the depth set within the range of 0.01 to 0.3 mm and extending in the longitudinal directions of the groove are arranged at the pitch set within the range of 0.01 to 0.3 mm. Therefore, the resistance to the water flowing in the grooves is reduced to improve the drainage efficiency of the grooves. As a result, it is possible to improve the wet performances of the tire.

[0015]

The present invention according to claim 2 is a tire comprising: a tread; a plurality of grooves mutually intersecting and being provided in the tread; and a plurality of smaller grooves formed in the walls of the grooves so as to extend in the longitudinal directions of the grooves, wherein: the smaller grooves have a depth set within a range of 0.01 to 0.3 mm and a pitch set within a range of 0.01 to 0.3 mm; and the walls in the vicinity of the confluence of the grooves are provided with turbulence generating zones for generating minute turbulences in a fluid flowing in the vicinity of the groove walls to thereby suppress separation of the fluid flowing in the grooves.

[0016]

Next, operation of the tire according to claim 2 will be described.

[0017]

In the tire according to claim 2, the smaller grooves having the depth set within the range of 0.01 to 0.3 mm and extending in the longitudinal directions of the groove are arranged at the pitch set within the range of 0.01 to 0.3 mm. Therefore, the resistance to the water flowing in the grooves is reduced to improve the drainage efficiency of the grooves.

[0018]

Further, the turbulence generating zone at the groove wall in the vicinity of the confluence between the grooves generates minute turbulences in the fluid flowing in the vicinity of the groove walls to suppress the separation of the fluid to flow in the groove. As a result, it is possible to further improve the wet performances of the tire.

[0019]

The invention according to claim 3 is the tire of claim 1 or 2, wherein the walls in the vicinity of the opening of the groove on the tread surface side are provided with turbulence generating zones for generating minute turbulences in a fluid flowing in the vicinity of the groove walls to thereby

suppress separation of the fluid flowing in the groove.

[0020]

Operation of the tire according to claim 3 will be described next.

[0021]

When the water on the wet road surface flows into the groove through the opening in the tread surface during the run on the road surface, it can enter the groove with a low resistance because the minute turbulences are generated in the fluid flowing in the vicinity of the groove wall by the turbulence generating zone disposed at the groove wall in the vicinity of the opening.

[0022]

As a result, the wet performances of a new tire are further improved.

[0023]

The invention according to claim 4 is the tire of claim 2 or 3, wherein the turbulence generating zones have a multiplicity of pointed projections having a diameter within a range of 0.01 to 0.3 mm and a height within a range of 0.01 to 0.3 mm.

[0024]

Next, operation of the tire according to claim 4 will be described.

[0025]

In the tire according to claim 4, the numerous pointed projections having a diameter within the range of 0.01 to 0.3 mm and a height within the range of 0.01 to 0.3 mm generate the numerous minute turbulences in the vicinity of the groove walls to thereby suppress the separation of the water flow.

[0026]

The invention according to claim 5 is the tire of claim 2 or 3, wherein the turbulence generating zones have a multiplicity of recesses having a diameter within a range of 0.01 to 0.3 mm and a depth within a range of 0.01 to 0.3 mm.

[0027]

Operation of the tire according to claim 5 will be described next.

[0028]

In the tire according to claim 4, the numerous recesses having a diameter within the range of 0.01 to 0.3 mm and a height

within the range of 0.01 to 0.3 mm generate the numerous minute turbulences in the vicinity of the groove walls to thereby suppress the separation of the water flow.

[0029]

[Embodiments]

[First Embodiment]

A first embodiment of the tire of the invention will be described with reference to Figs. 1 to 4.

[0030]

As shown in Fig. 2, a tire 10 is provided at its tread 12 with a plurality of blocks 18 which are defined by a plurality of circumferential grooves 14 extending in circumferential directions of the tire (i.e., in the direction of arrow A and in the direction of arrow B) and a plurality of transverse grooves 16 intersecting those circumferential grooves 14.

[0031]

The tire 10 of this embodiment has an internal structure identical to that of the normal (pneumatic) tire so that the description on the internal structure will be omitted. Here, the tire 10 of this embodiment is a pneumatic tire but can be applied to a tire (e.g., a solid rubber tire) other than the pneumatic tire.

[0032]

As shown in Fig. 1, riblets 20 are formed individually on the side and bottom walls of each circumferential groove 14 and on the side and bottom walls of each transverse groove 16.

[0033]

In the riblets 20 of this embodiment, as shown in Fig. 3, smaller grooves 22, which extend in the longitudinal directions of the groove (i.e., the circumferential groove 14 or the transverse groove 16) while presenting a triangular section, are formed consecutively in the transverse directions (i.e., in the widthwise directions of the smaller grooves 22).

[0034]

The smaller grooves 22 have the depth groove D set within a range of 0.01 to 0.3 mm and the pitch P set within the range of 0.01 to 0.3 mm.

[0035]

On the other hand, the intersecting portion between the circumferential groove 14 and the transverse groove 16 provides a predetermined width W as a turbulence generating zone 23, which is provided at random with a number of pointed projections

24, as shown in Fig. 4. Here, the width W is preferred to be 1 mm or more.

[0036]

The pointed projection 24 of this embodiment has a bulging spherical shape (i.e., a portion of a sphere) and has a diameter d1 set within the range of 0.01 to 0.3 mm and a height H set within the range of 0.01 to 0.3 mm.

[0037]

Here, the ratio of the pointed projections 24 in the unit area of the aforementioned zone is preferred to be 30 % or more.

(Operation)

In the tire 10 of this embodiment, the circumferential groove 14 and the transverse groove 16 are provided with the smaller grooves 22, which have the groove depth D set within the range of 0.01 to 0.3 mm, at the pitch P within the range of 0.01 to 0.3 mm, so that the resistance to the water to flow in the grooves is reduced to improve the drainage efficiency of the grooves.

[0038]

On the other hand, the separation of the water flow in the vicinity of the confluence between the circumferential

groove 14 and the transverse groove 16 is suppressed by the numerous pointed projections 24 which are formed on the groove sides in the vicinity of the confluence.

[0039]

As a result, it is possible to improve the wet performance of the tire 10 further than is possible with the prior art.

[Second Embodiment]

A tire according to a second embodiment of the invention will be described with reference to Fig. 5. Here is omitted the description of the same components as those of the foregoing embodiment by designating the components by the common reference numerals.

[0040]

In the tire 10 of this embodiment, the turbulence generating zone 23 is provided at the groove sides on the tread surface side of the predetermined width W, as shown in Fig. 5, in addition to the confluence between the circumferential groove 14 and the transverse groove 16.

(Operation)

When the tire 10 runs on a wet road surface so that the water on the road surface comes through the openings in the tread into the circumferential groove 14 and the transverse

groove 16, turbulent flows are established in the water flowing in the vicinities of the grooves sides by the numerous pointed projections 24 near the openings. As a result, the separation of the coming water can be suppressed to allow the water on the road to flow with a lower resistance into the grooves.

[0041]

As a result, it is possible to improve the wet performance of the tire 10, as newly used.

[Third Embodiment]

A tire according to a third embodiment of the invention will be described with reference to Fig. 6. Here is omitted the description of the same components as those of the foregoing embodiments by designating the components by the common reference numerals.

[0042]

The tread pattern of the tire 10 of this embodiment is a rib pattern so that the tread 12 is provided exclusively with the circumferential grooves 14 having the riblets 20, as shown in Fig. 6.

[0043]

In the tire 10 of this embodiment, the resistance experienced at the circumferential grooves 14 can be reduced

as in the foregoing embodiments so that the wet performance can be improved further than is possible with the tire of the rib pattern of the prior art.

[Fourth Embodiment]

A tire according to a fourth embodiment of the invention will be described with reference to Fig. 7. Here is omitted the description of the same components as those of the foregoing embodiments by designating the components by the common reference numerals.

[0044]

The tread pattern of the tire 10 of this embodiment is a rib pattern as in the third embodiment so that the tread 12 is provided exclusively with the circumferential grooves 14 having the riblets 20 and the pointed projections 24, as shown in Fig. 7.

[0045]

In the tire 10 of this embodiment, the numerous pointed projections 24 are formed on the groove sides in the vicinities of the openings on the tread surface side, so that the water on the tread can easily come from the openings to improve the wet performance further than the third embodiment.

[Other Embodiments]

Here, in the foregoing embodiments, in order to suppress

the separation of the water flow, the numerous pointed projections 24 are formed on the groove sides to establish the turbulent flows. However, the invention should not be limited thereto, but the pointed projections 24 can be replaced by a number of small recesses 28, as shown in Fig. 8. In this modification as well, it is possible to achieve the operations and effects similar to those of the case in which the numerous pointed projections 24 are formed.

[0046]

Here, the recesses 28 shown in Fig. 8 are formed into a recessed spherical shape having a diameter d2 set within the range of 0.01 to 0.3 mm and a depth D1 set within the range of 0.01 to 0.3 mm. The recesses 28 preferably take up 30% or more of the surface area.

[0047]

In the foregoing embodiment, the pointed projections 24 have the bulging spherical shape. However, the invention should not be limited thereto but may be formed into another shape such as a triangular pyramid shape.

[0048]

On the other hand, the recesses 28 should not be limited to the recessed spherical shape but may be formed into another

shape.

[0049]

Moreover, in the riblets 20 of the foregoing embodiments, the smaller grooves 22 having the triangular section are formed continuously in the transverse directions, but more or less spacings may be formed between the smaller grooves 22 and the smaller grooves 22 if the effect of reducing the resistance to the water flow is retained.

[0050]

Here, the riblets 20 have been described to be formed by arranging the numerous smaller grooves 22 but may be exemplified by a number of rib-shaped projections (or ridges) juxtaposed to each other. In this modification, the spacings between the rib-shaped projections and the rib-shaped projections correspond to the smaller grooves 22.

[0051]

The smaller grooves 22 have the triangular sectional shape but may be replaced by another shape such as a rectangular, trapezoidal or semicircular shape if they have the effect of reducing the resistance to the water flow.

(Test Example 1)

In order to confirm the effects of the invention, two

kinds of Comparative Example tires of a size PSR185/70R14 and three kinds of Example tires were prepared according to the present invention to compare the anti-hydroplaning performances.

[0052]

The test tires will hereinafter be described.

[0053]

All the test tires have the block pattern shown in Fig. 2, and the blocks 18 have a size of 30 mm in the tire circumferential directions, a size of 30 mm in the tire widthwise directions and a height (or a groove depth) of 8 mm.

* Tire of Comparative Example 1: The tire (i.e., the ordinary tire of the prior art) which is worked to have smooth side faces and bottom face of the circumferential groove 14 and the transverse groove 16, as shown in Fig. 9.

* Tire of Example 1: The tire in which the riblets 20 are formed in all the groove side faces and the bottom face, as shown in Fig. 10, and in which the smaller grooves 22 have a depth D of 0.05 mm and a pitch P of 0.05 mm.

* Tire of Example 2: The tire having the groove wall shape shown in Fig. 1. The recesses 28 having the diameter d2 of 1.2 mm and the depth D1 of 0.2 mm are arranged at random (e.g., the density: 35 %) in the turbulence generating zone 23 having

the width of 5 mm of the groove side faces in the vicinity of the confluence between the circumferential groove 14 and the transverse groove 16. The smaller grooves 22 are identical to those of Example 1.

* Tire of Example 3: The tire having the groove wall shape shown in Fig. 11. The recesses 28 having the diameter d2 of 0.2 mm and the depth D1 of 0.04 mm are arranged at random (e.g., the density: 40 %) in the turbulence generating zone 23 having the width of 1 mm of the groove side faces in the vicinity of the opening on the side of the tread surface. The smaller grooves 22 are identical to those of Example 1.

* Tire of Example 4: The tire having the groove wall shape shown in Fig. 5. The recesses 28 having the diameter d2 of 1.2 mm and the depth D1 of 0.2 mm are arranged at random (e.g., the density: 30 %) in the turbulence generating zone 23 having the width of 5 mm of the groove side faces in the vicinity of the confluence between the circumferential groove 14 and the transverse groove 16. The recesses 28 having the diameter d2 of 0.2 mm and the depth D1 of 0.04 mm are arranged at random (e.g., the density: 35 %) in the turbulence generating zone 23 having the width of 1 mm in the vicinity of the groove side faces of the opening on the tread surface side. The smaller grooves are identical to those of Example 1.

* Tire of Comparative Example 2: The tire in which the riblets 20 are formed on all the groove side faces and the bottom

face. However, the smaller grooves 22 have the depth D of 1.0 mm and the pitch of 1.0 mm.

[0054]

* Testing Methods: The test tires were assembled with the rims of 5J-14 under the internal pressure of 2.0 Kgf/cm^2 (200 kPa) and were attached to a passenger car. This car was driven to run into the pool of the depth of 10 mm at various speeds. The hydroplaning occurrence rates were evaluated by the test driver.

[0055]

The evaluations were determined in terms of the hydroplaning occurrence rates and were exponentially expressed by setting the tire of Comparative Example 1 to 100. It is expressed that the larger numerical value indicates the higher hydroplaning occurrence rate and the more excellent wet performance.

[0056]

[Table 1]

	Wet Perf.
Com. Example 1	100
Example 1	105
Example 2	109
Example 3	108
Example 4	111
Com. Example 2	95

[0057]

(Test Example 2)

In order to confirm the effects of the present invention, two kinds of Comparative Example tires of a size PSR235/45R17 and three kinds of Example tires were prepared according to the present invention to compare the anti-hydroplaning performances.

[0058]

The test tires will hereinafter be described.

[0059]

All the test tires have the block pattern shown in Fig. 12, and the blocks 18 have a size of 35 mm in the tire circumferential directions, a size of 30 mm in the tire widthwise directions and a height (or a groove depth) of 8 mm.

* Tire of Comparative Example 1: The tire (i.e., the ordinary tire of the prior art) which is worked to have smooth side faces and bottom face of the circumferential groove 14 and the transverse groove 16, as shown in Fig. 9.

* Tire of Example 1: The tire in which the riblets 20 are formed in all the groove side faces and the bottom face, as shown in Fig. 10, and in which the smaller grooves 22 have a depth D of 0.1 mm and a pitch P of 0.1 mm.

* Tire of Example 2: The tire having the groove wall shape shown in Fig. 1. The recesses 28 having the diameter d2 of 0.14 mm and the depth D1 of 0.15 mm are arranged at random (e.g., the density: 30 %) in the turbulence generating zone 23 having the width of 5 mm of the groove side faces in the vicinity of the confluence between the circumferential groove 14 and the transverse groove 16. The smaller grooves 22 are identical to those of Example 1.

* Tire of Example 3: The tire having the groove wall shape shown in Fig. 11. The recesses 28 having the diameter d2 of 0.4 mm and the depth D1 of 0.08 mm are arranged at random (e.g., the density: 35 %) in the turbulence generating zone 23 having the width of 1 mm of the groove side faces in the vicinity of the opening on the side of the tread surface. The smaller grooves 22 are identical to those of Example 1.

* Tire of Example 4: The tire having the groove wall shape shown in Fig. 5. The recesses 28 having the diameter d2 of 1.4 mm and the depth D1 of 0.15 mm are arranged at random (e.g., the density: 40 %) in the turbulence generating zone 23 having the width of 5 mm of the groove side faces in the vicinity of the confluence between the circumferential groove 14 and the transverse groove 16. The recesses 28 having the diameter d2 of 0.4 mm and the depth D1 of 0.08 mm are arranged at random (e.g., the density: 45 %) in the turbulence generating zone 23 having a width of 1 mm on the groove side faces in the vicinity

of the opening on the tread surface side. The smaller grooves are identical to those of Example 1.

* Tire of Comparative Example 2: The tire in which the riblets 20 are formed on all the groove side faces and the bottom face. However, the smaller grooves 22 have the depth D of 1.0 mm and the pitch of 1.0 mm.

[0060]

* Testing Methods: The test tires were assembled with the rims of 8JJ-17 under the internal pressure of 2.2 Kgf/cm2 (220 kPa) and were attached to a passenger car. This car was driven to run into the pool of the depth of 10 mm with a curve having a radius of 130 m at various speeds. The hydroplaning occurrence rates were evaluated by the test driver.

[0061]

The evaluations were determined in terms of the hydroplaning occurrence rates and were exponentially expressed by setting the tire of Comparative Example 1 to 100. It is expressed that the larger numerical value indicates the higher hydroplaning occurrence rate and the more excellent wet performance.

[0062]

[Table 2]

	Wet Perf.
Com. Example 1	100
Example 1	106
Example 2	110
Example 3	109
Example 4	114
Com. Example 2	93

[0063]

(Test Example 3)

In order to confirm the effects of the invention, two kinds of Comparative Example tires of a size TBR295/70R22.5 and three kinds of Example tires were prepared according to the present invention to compare the wet braking performances.

[0064]

The test tires will hereinafter be described.

[0065]

All the test tires have the block pattern shown in Fig. 12, and the blocks 18 have a size of 35 mm in the tire circumferential directions, a size of 30 mm in the tire widthwise directions and a height (or a groove depth) of 12 mm.

* Tire of Comparative Example 1: The tire (i.e., the ordinary tire of the prior art) which is worked to have smooth side faces and bottom face of the circumferential groove 14 and the transverse groove 16, as shown in Fig. 9.

* Tire of Example 1: The tire in which the riblets 20 are formed in all the groove side faces and the bottom face, as shown in Fig. 10, and in which the smaller grooves 22 have a depth D of 0.1 mm and a pitch P of 0.1 mm.

* Tire of Example 2: The tire having the groove wall shape shown in Fig. 1. The recesses 28 having the diameter d2 of 0.14 mm and the depth D1 of 0.15 mm are arranged at random (e.g., the density: 40 %) in the turbulence generating zone 23 having the width of 5 mm of the groove side faces in the vicinity of the confluence between the circumferential groove 14 and the transverse groove 16. The smaller grooves 22 are identical to those of Example 1.

* Tire of Example 3: The tire having the groove wall shape shown in Fig. 11. The recesses 28 having the diameter d2 of 0.4 mm and the depth D1 of 0.08 mm are arranged at random (e.g., the density: 45 %) in the turbulence generating zone 23 having the width of 1 mm of the groove side faces in the vicinity of the opening on the side of the tread surface. The smaller grooves 22 are identical to those of Example 1.

* Tire of Example 4: The tire having the groove wall shape shown in Fig. 5. The recesses 28 having the diameter d2 of 1.4 mm and the depth D1 of 0.15 mm are arranged at random (e.g., the density: 50 %) in the turbulence generating zone 23 having the width of 5 mm of the groove side faces in the vicinity of the confluence between the circumferential groove 14 and the

transverse groove 16. The recesses 28 having the diameter d2 of 0.4 mm and the depth D1 of 0.08 mm are arranged at random (e.g., the density: 40 %) in the turbulence generating zone 23 having a width of 1 mm on the groove side faces in the vicinity of the opening on the tread surface side. The smaller grooves are identical to those of Example 1.

* Tire of Comparative Example 2: The tire in which the riblets 20 are formed on all the groove side faces and the bottom face. However, the smaller grooves 22 have the depth D of 1.0 mm and the pitch P of 1.0 mm.

[0066]

* Testing Methods: The test tires were assembled with the rims of 9.00 under the internal pressure of 9.0 Kgf/cm^2 (900 kPa) and were attached to a motor truck. This motor truck was driven to run at a speed of 80 Km/h into the pool of the depth of 10 mm. The braking stop distances were evaluated by the test driver.

[0067]

The evaluations were determined by measuring the braking stop distances and were exponentially expressed by setting the tire of the conventional example to 100. It is expressed that the smaller numerical value indicates the shorter stop distance and the more excellent wet braking

performance.

[0068]

[Table 3]

	Wet Braking Perf.
Com. Example 1	100
Example 1	96
Example 2	94
Example 3	95
Example 4	93
Com. Example 2	103

[0069]

[Effects of the Invention]

With the construction thus far described, the tire according to claim 1 can have the excellent effects of reducing the resistance to the water flowing in the grooves and thus improving the drainage efficiency of the grooves, thereby improving the wet performances.

[0070]

With the above-described construction, the tire according to claim 2 has an excellent effect of further improving the wet performances of the tire by suppressing the separation of the fluid flowing in the groove.

[0071]

With the above-described construction, the tire according to claim 3 has an excellent effect of further improving the wet performances of a new tire since the water on the road surface enters the groove with a low resistance.

[0072]

With the above-described construction, the tire according to claim 4 has an excellent effect of suppressing the separation of the water flow by the numerous pointed projections generating the numerous minute turbulences in the vicinity of the groove walls.

[0073]

With the above-described construction, the tire according to claim 5 has an excellent effect of suppressing the separation of the water flow by the numerous recesses generating the numerous minute turbulences in the vicinity of the groove walls.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1]

Fig. 1 is an enlarged perspective view of the tread of a tire according to the first embodiment.

[Fig. 2]

Fig. 2 is a top plan view of the tread of the tire.

[Fig. 3]

Fig. 3 is an enlarged perspective view of a riblet.

[Fig. 4]

Fig. 4 is an enlarged perspective view of pointed projections.

[Fig. 5]

Fig. 5 is an enlarged perspective view of the tread of a tire according to the second embodiment.

[Fig. 6]

Fig. 6 is an enlarged perspective view of the tread of a tire according to the third embodiment.

[Fig. 7]

Fig. 7 is an enlarged perspective view of the tread of a tire according to the fourth embodiment.

[Fig. 8]

Fig. 8 is an enlarged perspective view of recesses.

[Fig. 9]

Fig. 9 is an enlarged perspective view of a tread of a tire according to Comparative Example 1.

[Fig. 10]

Fig. 10 is an enlarged perspective view of a tread of a tire according to Example 1.

[Fig. 11]

Fig. 11 is an enlarged perspective view of a tread of a tire according to Example 3.

[Fig. 12]

Fig. 12 is a top plan view of a tread and shows a block pattern of tires of Test Examples 2 and 3.

[Description of the Reference Numerals]

10: tire

12: tread

14: circumferential grooves

16: transverse grooves

22: smaller grooves

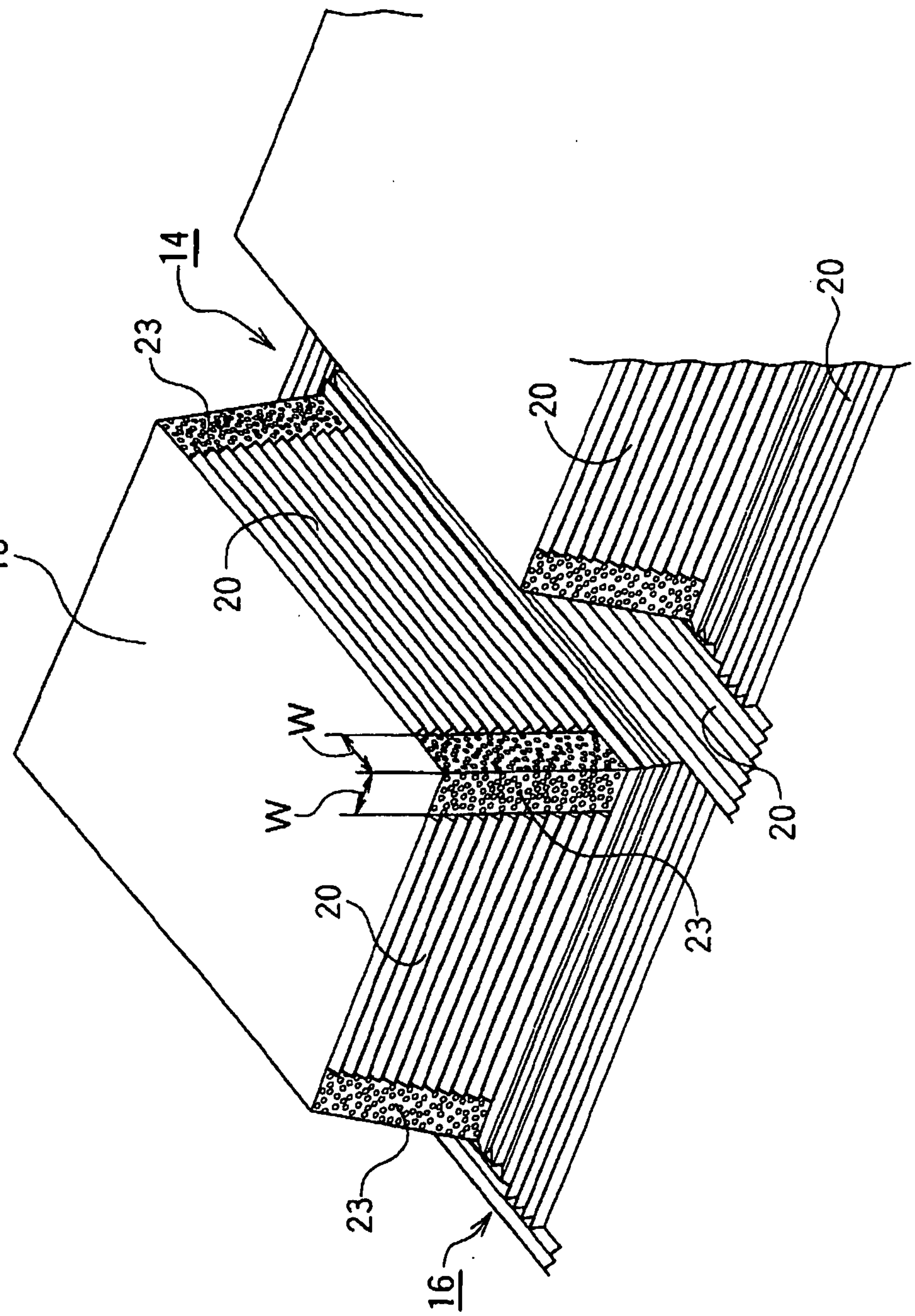
23: turbulence generating zone

24: pointed projections

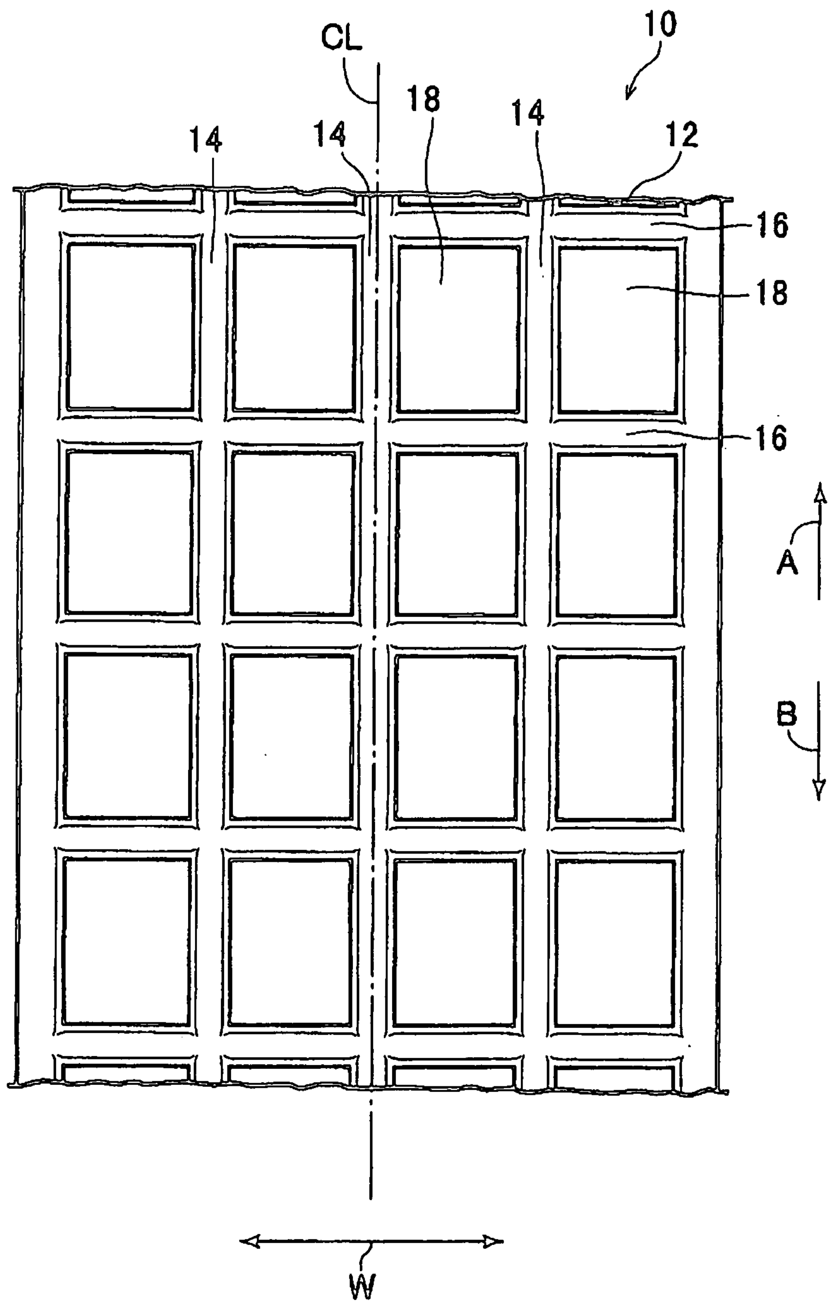
28: recesses

[DOCUMENT NAME] DRAWINGS

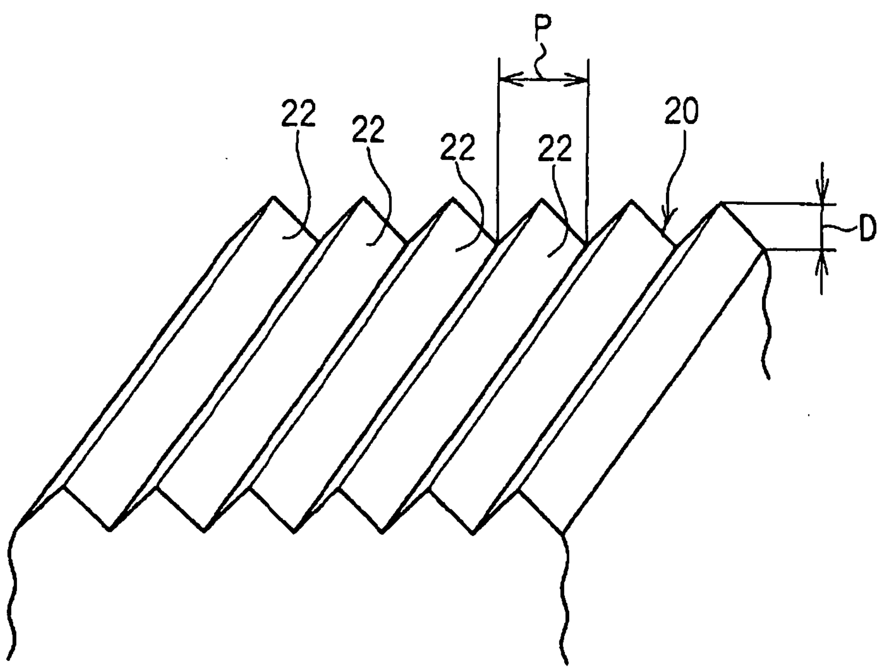
[FIG. 1]



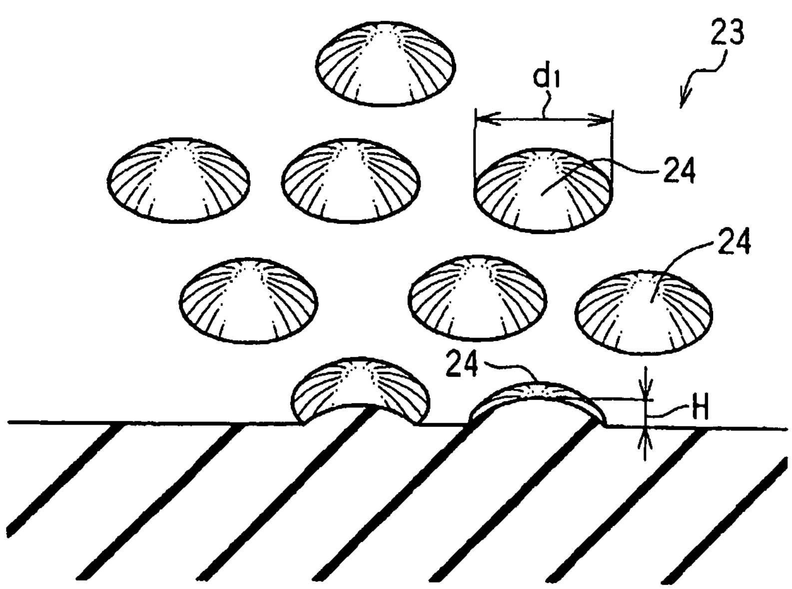
[FIG. 2]



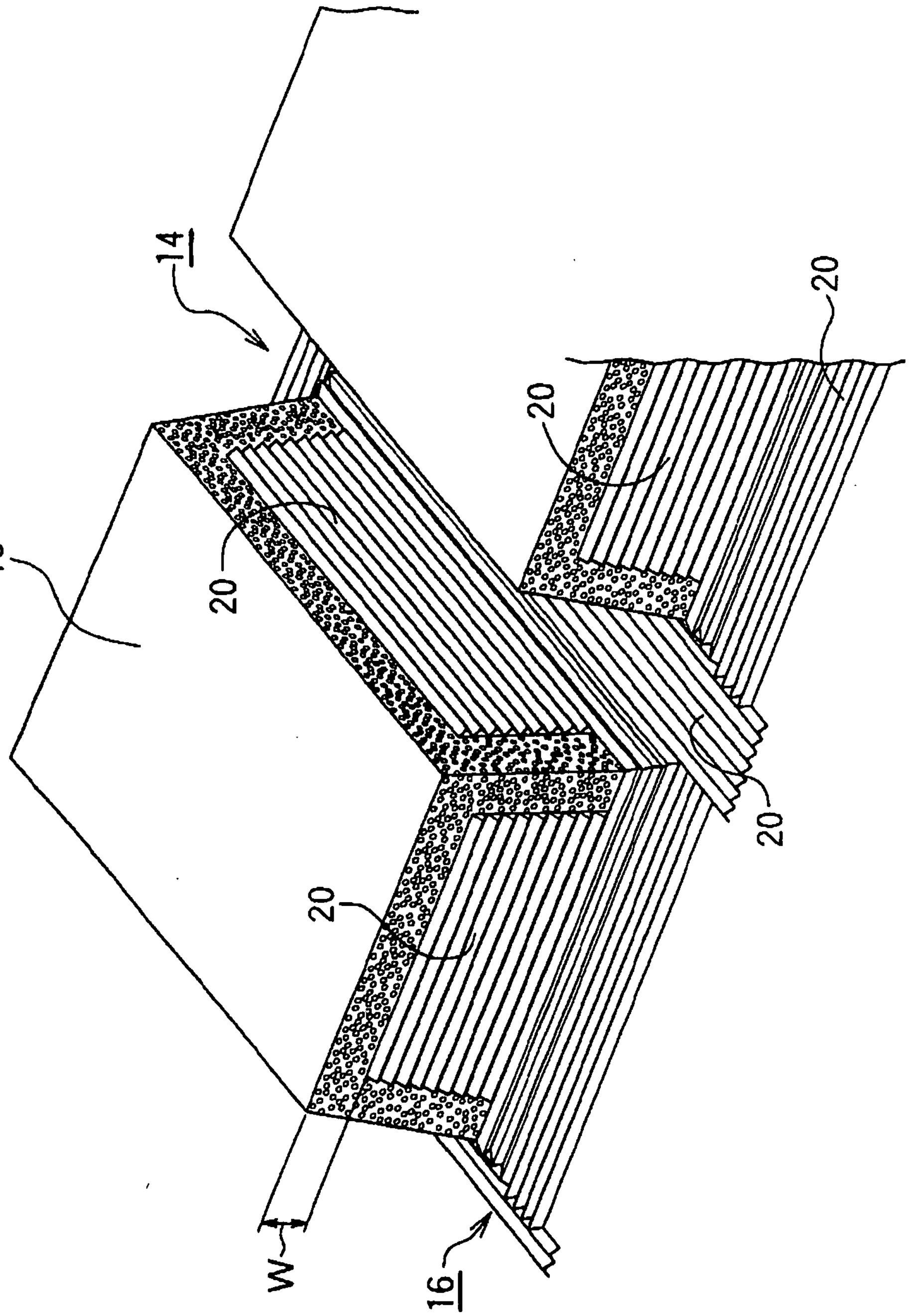
[FIG. 3]



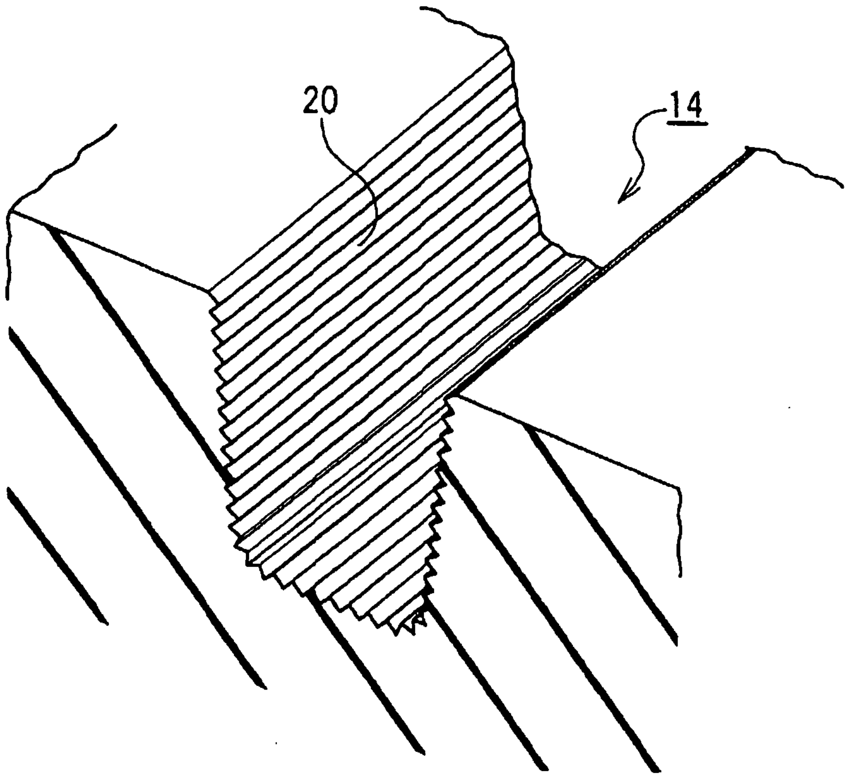
[FIG. 4]



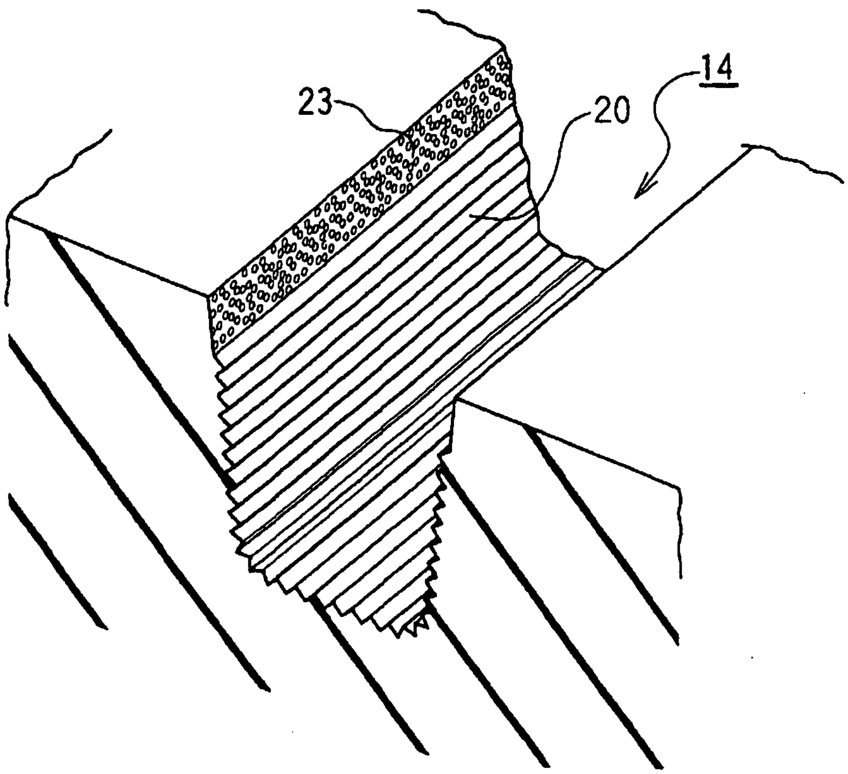
[FIG. 5]



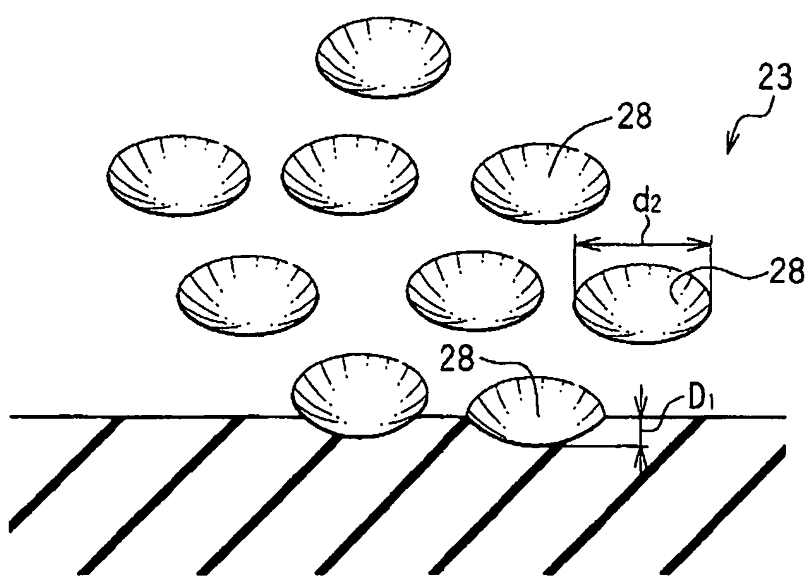
[FIG. 6]



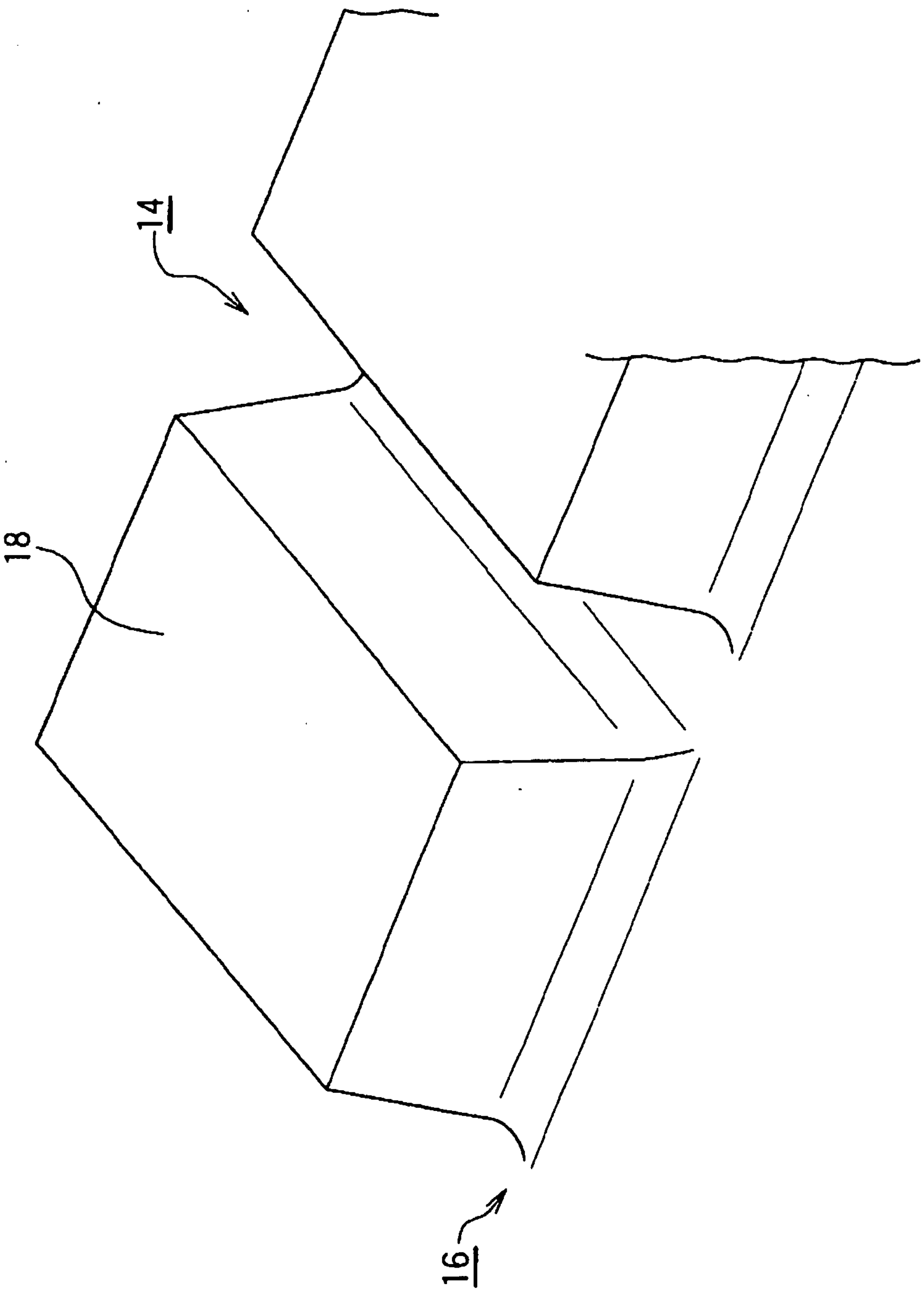
[FIG. 7]



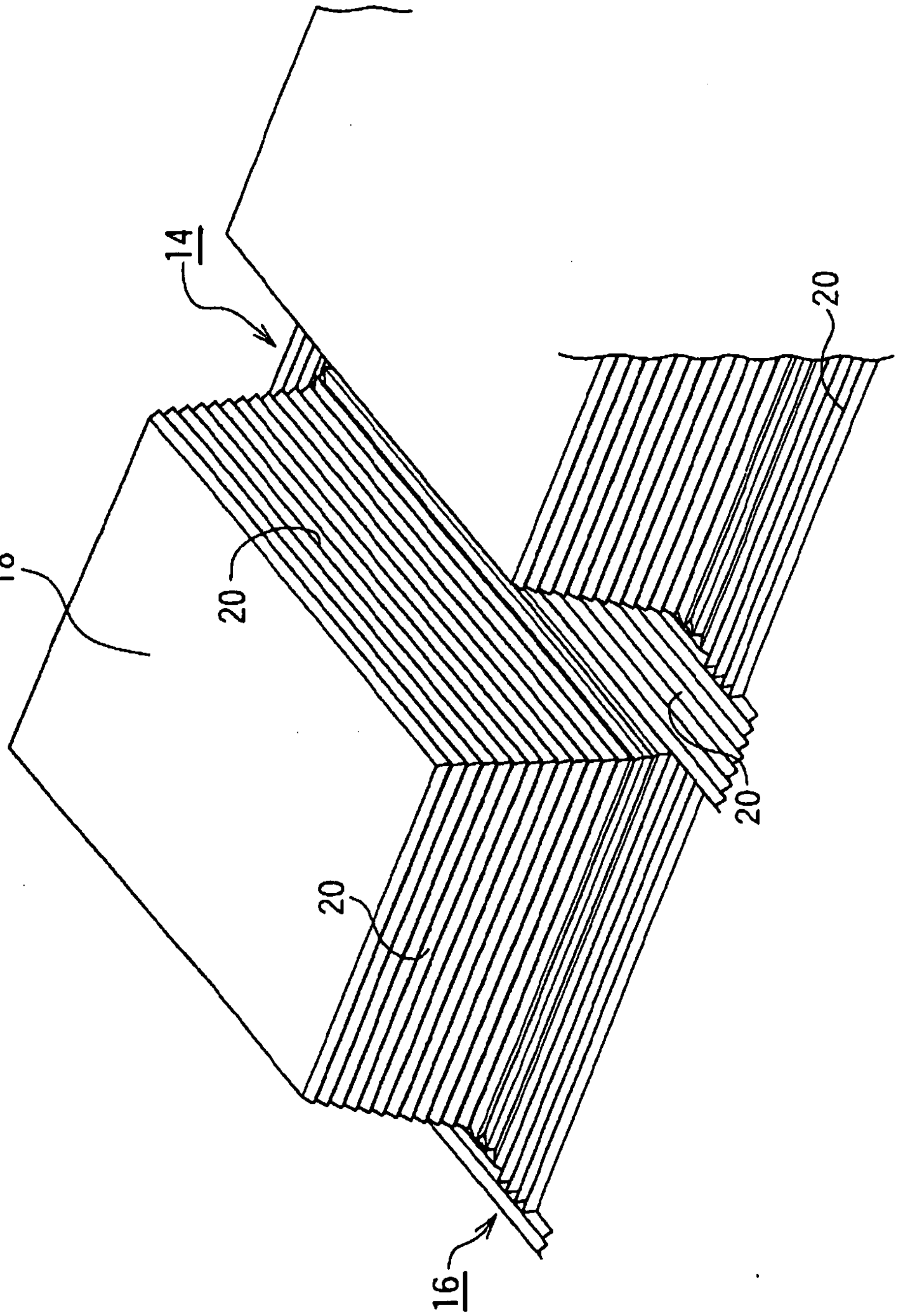
[FIG. 8]



[FIG. 9]



[FIG. 10]



[FIG. 11]